

AUG 20 2007

10/585,793

RemarksA. Basis for claim amendments

Basis for the amendments to independent claim 1 includes page 3, line 24 to page 4, line 26 of the verified translation of the application filed on July 12, 2006.

Further basis for the amendments to independent claim 1 includes original dependent claim 2, which has been canceled.

Basis for new claim 6 includes page 3, line 24 to page 4, line 26 of the verified translation of the application filed on July 12, 2006.

B. The Office ActionB.1. IDS

On page 2 of the Office Action, acknowledgement of applicant's IDS filed on July 12, 2006 was made. This is appreciated.

B.2. Priority document

On page 2 of the Office Action, acknowledgement was made of applicant's claim for foreign priority based on an application filed in Japan on January 30, 2004. This is appreciated.

As to a certified copy of JP 2004-024181, this is a PCT case. The certified copy is provided to the USPTO by WIPO. Please see MPEP 1896.

B.3. Claim rejections

On page 3 of the Office Action, claims 1, 2 and 4 were rejected under 35 U.S.C. 103(a) as being unpatentable over Tenten et al. (US 5,677,261), in view of Neher et al. (US 5,387,720).

(18450.DOC) (Amendment and Remarks--page 4 of 10)

10/585,793

On page 4 of the Office Action, claim 3 was rejected under 35 U.S.C. 103(a) as being unpatentable over Tenten et al. (US 5,677,261), in view of Neher et al. (US 5,387,720), and further in view of Unverricht et al. (US 6,403,829).

On page 5 of the Office Action, claim 5 was rejected under 35 U.S.C. 103(a) as being unpatentable over Tenten et al. (US 5,677,261), in view of Neher et al. (US 5,387,720), and further in view of Uchida et al. (US 4,871,700).

C. Applicant's discussion

There are the following differences between the claimed process and the cited prior art process.

Firstly, of the dehydration reaction step and the oxidation reaction step of the claimed process, Neher discloses only the dehydration reaction step where acrolein is produced from glycerol, and Tenten discloses only the oxidation reaction step where acrylic acid is produced from acrolein. Therefore, neither Neher nor Tenten discloses the one continuous (integrated) process of both the dehydration reaction step and the oxidation reaction step such as the claimed process. Therefore, a skilled artisan would not have thought of carrying out the dehydration reaction step and the oxidation reaction step in one continuous (integrated) process by combining Neher and Tenten.

Secondly, Neher teaches that as the glycerol concentration in the aqueous glycerol solution increases (particularly, "above 40 wt. %"), the yield of acrolein decreases (column 2, lines 52-56). Therefore, even if a skilled artisan had thought of the above-mentioned one continuous (integrated) process, he or she would have set the glycerol concentration of the aqueous glycerol solution

(18450.DOC) (Amendment and Remarks--page 5 of 10)

10/585,793

not to be high, but to be low (specifically, 40 wt % or lower) according to this teaching of Neher in order to obtain acrylic acid from acrolein in a high yield. However, in the claimed one continuous (integrated) process, although an aqueous glycerol solution having a high glycerol concentration of not less than 50 wt % (as clear from the claimed water content of not more than 50 wt %) which according to the teaching of Neher is presumed to only give a low yield of acrylic acid is used, nevertheless acrylic acid is obtained in a high yield. This is a prominent effect of the claimed process and is unexpected from the simple combination of Neher and Tenten.

Incidentally, the reason why such excellent results with regard to the yield of acrylic acid are obtained in the claimed process appears to be that the gas formed by the dehydration reaction step is intactly used as a raw material for the gas phase oxidation reaction step.

Thirdly, in the process of Neher, since an aqueous glycerol solution having a low glycerol concentration of 10 to 40 wt % (in other words, a high water content of 60 to 90 wt %) is used, a larger amount of water is involved relative to a definite amount of glycerol. As a result the aqueous glycerol solution needs much energy to vaporize and also involves an enormous cost of wastewater treatment, and is therefore so disadvantageous economically as to hamper the industrial implementation of the process (page 3, lines 14-23 of the verified translation of the present application). On the other hand, in the claimed process, since an aqueous glycerol solution having a low water content of not more than 50 wt % is used, such problems are prevented.

(18450.DOC) (Amendment and Remarks--page 6 of 10)

10/585,793

The above second and third differences are demonstrated as follows.

If, as suggested by the Examiner, Neher and Tenten are combined, namely, acrolein is produced by a dehydration reaction of glycerol in accordance with the teaching of Neher and then acrylic acid is produced by a gas phase oxidation reaction of the above-produced acrolein in accordance with the teaching of Tenten, then the yield of acrylic acid in total from glycerol can be estimated by the following formula.

$$\begin{aligned} &(\text{Yield of acrylic acid in total from glycerol}) (\text{mol } \%) = \\ &(\text{Yield of acrolein from glycerol in Neher}) (\text{mol } \%) \times (\text{Yield} \\ &\text{of acrylic acid from acrolein in Tenten}) (\text{mol } \%) \end{aligned}$$

Hereupon, for example, illustrated by Example 1 and Comparative Example VB 2 of Neher in combination with Tenten, the yield of acrylic acid in total from glycerol can be estimated as shown in the following table from the above formula and from Table 2 in column 15 of Tenten. In addition, the yield of acrylic acid in total from glycerol in Example 2 of the present application is also shown in the following table together with the amounts (kg) of water to be vaporized per 1 kg of glycerol from aqueous glycerol solutions in those Examples.

10/585,793

Example	Glycerol concentration in its aqueous solution (wt. %)	Yield of acrolein from glycerol in Neher (mol %)	Yield of acrylic acid from acrolein in Tenten (mol %) *1	Yield of acrylic acid in total from glycerol (mol %)	Amount (kg) of water to be vaporized per 1 kg of glycerol
Example 1 of Neher	20	70.5	95.2	67.1 (estimated value *2)	4.00
Comparative Example VB 2 of Neher	80	45	95.2	42.8 (estimated value *2)	0.25
Example 2 of present application	91	--	--	63	0.10

(Footnotes)

- *1: Yield of acrylic acid from acrolein in Tenten (mol %) as disclosed in column 15, Table 2 of Tenten.
- *2: (Yield of acrylic acid in total from glycerol) (mol %) = (Yield of acrolein from glycerol in Neher) (mol %) * (Yield of acrylic acid from acrolein in Tenten) (mol %)

As shown in the table above, as to Example 1 of Neher where the glycerol concentration in an aqueous glycerol solution is a low value of 20 wt %, the yield of acrylic acid in total from glycerol as estimated in combination with Tenten is a high value of 67.1 mol %, but it is necessary to vaporize as much as 4.00 kg of water per 1 kg of glycerol. In addition, as to Comparative Example VB 2 of Neher where the glycerol concentration in an aqueous glycerol solution is a high value of 80 wt %, the amount of water to be vaporized per 1 kg of glycerol is a small value of 0.25 kg, but the yield of acrylic acid in total from glycerol as estimated in combination with Tenten is greatly deteriorated to 42.8 mol %. On the other hand, as to Example 2 of the present application, the glycerol concentration in an aqueous glycerol solution is a high value of 91 wt % similarly to Comparative Example VB 2 of Neher, but the yield of acrylic acid in total from glycerol is almost as

(18450.DOC) (Amendment and Remarks--page 8 of 10)

10/585,793

high a value of 63.0 mol % as the above-estimated value for Example 1 of Neher, and further the amount of water to be vaporized per 1 kg of glycerol is much reduced to 0.10 kg which is only 1/40 of water needed for Example 1 of Neher.

In addition, according to the present inventors' discovery, when the glycerol dehydration reaction is carried out, allyl alcohol or 3-hydroxypropanealdehyde is formed as a by-product. Then, in the claimed process, since the gas formed by the first step (dehydration reaction) is intactly used as a raw material for the second step (gas phase oxidation reaction), the above by-product is oxidized in the second step and thereby converted into acrylic acid. In that meaning, the claimed process further has excellent merits such that the removal of the above by-product is made unnecessary, so that the above by-product can be recycled.

None of the Unverricht et al. and Uchida et al. references cures the deficiencies of the Neher et al. and Tenten et al. references discussed above.

Therefore, in light of the above, it is respectfully submitted that, even if combined, the Tenten et al. and Neher et al. references do not teach or suggest the limitations of independent claim 1 as amended. Allowance of independent claim 1 and its dependent claims 3-6 is respectfully requested.

D. Housekeeping matters

D.1. Period For Reply

A shortened statutory period for reply was set to expire three months from the mailing date of the Office Action of May 24, 2007. May 24, 2007 plus three months is August 24, 2007. This Amendment and Remarks is being filed

(18450.DOC) (Amendment and Remarks--page 9 of 10)

10/585,793

on or before Friday, August 24, 2007.

D.2. Status

The Office Action of May 24, 2007 was nonfinal.

D.3. Disposition Of Claims

Claims 1 and 3-6 are pending.

D.4. Application Papers

This case includes no drawings.

D.5. Priority under 35 U.S.C. §§ 119 and 120

Acknowledgement of the claim for foreign priority was made in the Office Action dated May 24, 2007. This is appreciated.

D.6. Attachments

As the Examiner has indicated, applicant has filed one PTO-1449 form in this case. This form has been initialed, signed and returned. This is very much appreciated.

E. Summary


Applicant respectfully submits that the present application is now in condition for allowance. The Examiner is respectfully invited to make contact with the undersigned by telephone if such would advance prosecution of this case.

Respectfully submitted,

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8-18-07

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(18450.DOC) (Amendment and Remarks--page 10 of 10)